

Clustering Small and Medium CO₂ Emitters for CCS

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1. Introduction, Goals and Research Questions

The main goal of the project was to develop a foundational understanding of clustering and business strategies that enable small and medium CO₂ emitters in Switzerland to collaborate on a shared carbon infrastructure. This culminated in a decision framework and a list of recommendations being made.

2. Method Overview and Materials

This goal was achieved by first doing literature research in order to understand the technologies used in carbon capture and how they could be implemented in clustering, as well as what parameters to look for when grouping emitters together. After performing a clustering on Switzerland and selecting an area for a case study, further calculation was done to get the technical, economic and energy parameters, which showcase if a cluster is viable.

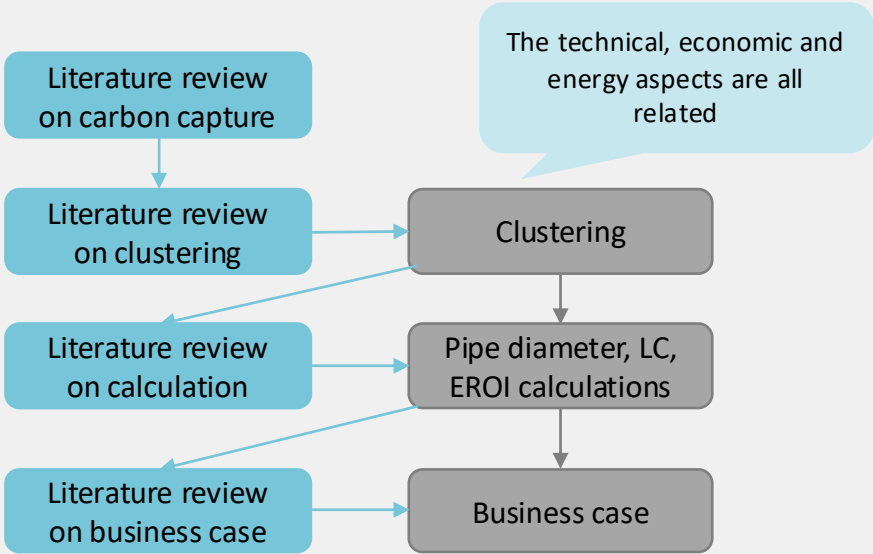


Figure: Methodology flowchart

The two most important formulas used were to calculate the Levelized Cost (CHF/t_{co2}) and the Energy Return on Energy Investment factors:

$$LC = \frac{CRF * I_{pump} + CRF * I_{pipe} + OM_{pump} + OM_{pipe} + EC_{pump}}{\dot{m} * H * 3.6}$$
$$EROI = \frac{E_g}{E_c + E_{op} + E_d}$$

3. Results and Discussion

The results showed that there are many parameters, such as CO₂ flow rates, pipe diameters and distances from hub, effecting the calculations, and the difficulty of getting concrete answers without having all the data and having to rely on assumptions. It was also discovered that one of the major barriers in creating a CCS cluster is creating a business model that will garner the acceptance of the stakeholders.

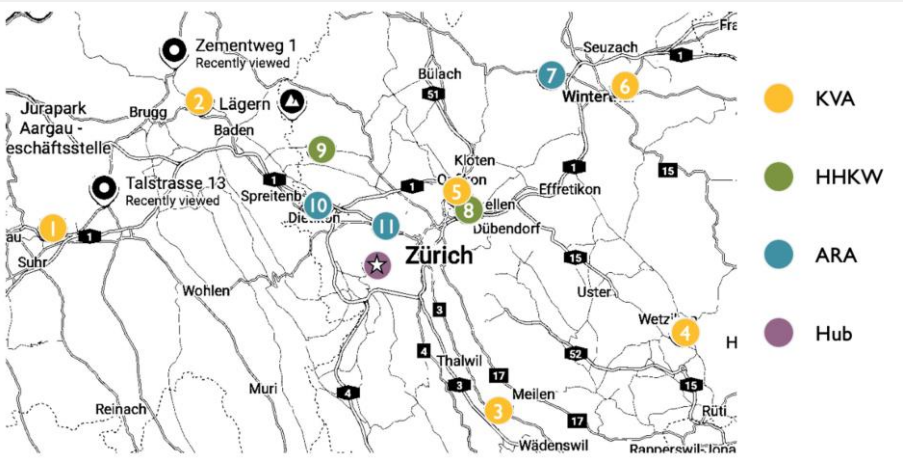


Figure: Zürich cluster

Emitter	Mass flow (kg/s)	Distance (km)	No. of stations	LC (CHF/t _{co2})
11	0.698	7.7	4	66.18
10	3.393	10.7	2	18.95
10	3.742	10.7	3	17.19
5	7.678	11	1	8.63
8	3.710	12.9	3	20.90
9	3.710	18.6	4	30.11
3	1.237	22	8	106.67
2	3.964	26.5	7	40.14
6	5.708	31.2	5	32.82
7	0.159	32.8	32	1236.67
7	6.183	35.6	7	34.57
1	4.598	38.3	4	49.96

Figure: Levelized cost of the emitters

4. Conclusion and Recommendations

The conclusion is that, while technologically CCS clustering is possible in Switzerland, there are still many uncertainties and assumptions being made while calculating. In order to present a tighter plan to investors and planned emitters, further research needs to be done.

References

1. Isoli, N., & Chaczykowski, M. (2025). Net energy analysis and net carbon benefits of CO₂ capture and transport infrastructure for energy applications and industrial clusters. *Applied Energy*, 382, 125227. <https://doi.org/10.1016/j.apenergy.2024.125227>